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## Should You Use Acceptance or Modified Control Charts?

Donald S. Holmes

A. Erhan Mergen

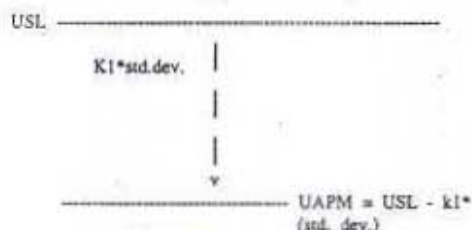
*\*continued from March issue of QC Report*

### How to build an AQL Acceptance Chart:

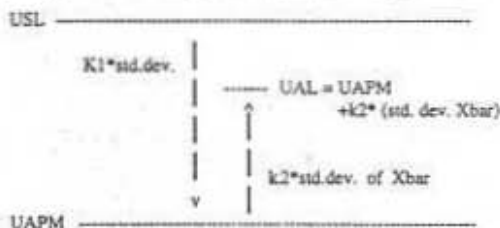
Here's how an AQL acceptance chart is constructed for subgroup sample averages. We'll use the Upper Spec Limit case to demonstrate the principal. The Lower Spec Limit case is done in essentially the same fashion.

Step 1. Decide on the AQL that you would consider appropriate for the process.

Step 2. Set a value known as the Upper Acceptable Process Mean (UAPM) at  $k_1 \cdot$  (standard deviation) below the upper spec limit. If the  $x$  values are roughly Normally distributed, then using  $k_1=2$  will produce an AQL value of approximately 2.5%.



Step 3. Add  $k_2 \cdot$  (Standard Deviation of  $\bar{X}$ ) to UAPM to arrive at the Upper Acceptance Limit (UAL) for the sample  $\bar{X}$ . The value of  $k_2$  sets the probability of acceptance of material that has a quality level of AQL. Choosing  $k_2 = 2$  would set the probability of accepting material that has a quality level of AQL to approximately 0.975.



Remember: the standard deviation of the  $\bar{X}$ s is the standard deviation of the  $x$ 's divided by the square root of the sample size.

Equations:

UAL for  $\bar{X}$ s for an AQL acceptance chart is calculated as:

$$\text{UAL} = \text{USL} - k_1 \cdot (\text{std. dev. of } x) + k_2 \cdot (\text{std. dev. of } \bar{x}) / \sqrt{n}$$



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LAL for  $\bar{X}$ s for an AQL acceptance chart is calculated as:

$$\text{LAL} = \text{LSL} + k_1 \cdot (\text{std. dev. of } x) / \sqrt{n}$$

For an RQL acceptance chart, simply change the sign of the  $k_2$  term in these equations.

Acceptance charts are similar to acceptance sampling. In acceptance sampling we make an accept (or reject) decision on a lot based on sample(s). Acceptance charts do the same thing on a process in a dynamic fashion (i.e., over time).

## Statistical Process Control Training

### Basic and Advanced Topics - 3 to 5 Day Course

June 26 -28 Basic ~ June 28 -30 Advanced

Course Director: Donald S. Holmes

**Course Description:** This course has two components: a two and 1/2 day basic overview and a two and 1/2 day advanced topics. The basic course deals with such standard tools as histograms,  $\bar{X}$  and R charts, process capability studies and sampling plans. The advanced course deals with statistical process control in automated industries: Key variable identification, regression, correlation, principal components, autocorrelation, discriminant analysis and evolutionary operation (EVOP). The course will cover the basic concepts of statistical analysis and their application to practical problems in process control.

- \* Review of basic SPC tools and advanced tools important to your type of industry

- \* Introduction to Control Charts
- \* Correlation and Regression, Acceptance Sampling
- \* Multiple Variables and Key Variable Identification
- \* Autocorrelation and Time Series Modeling
- \* Case studies used throughout discussions

Directed by: Donald S. Holmes  
President of Stochos, Inc.

Donald S. Holmes, who founded *STOCHOS* in 1968, is well versed in the teaching and application of quantitative methods to management systems. He is a Fellow of the American Society for Quality (ASQ) and a certified quality engineer.



## Upcoming Events Calendar

**July 17 - 19, 2000**

### **Unique SPC Workshop**

Statistical Analysis of Operations Data  
Held at: The Center for Prof. Advancement  
East Brunswick, NJ  
To Register Contact: CFPA (732) 238-1600

**August 21 - 24, 2000**

### **IMS Expo 2000**

New Orleans, Louisiana  
Ernest N. Morial Convention Center  
Booth #5316

**October 23 - 27, 2000**

### **Statistical Process Control Training**

Course Director: Donald S. Holmes  
Basic and Advanced Topics / 3 - 5 Day Course  
October 23 - 25 Basic & October 25 - 27 Advanced  
Registration: Basic \$800 Advanced \$1600  
Location: Stochos, Inc.  
14 N. College St.  
Schenectady, NY 12305

For more information contact: Konnie Steele  
(518) 372-5426, or email: Ksteele@Stochos.com

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Action: Take samples of size 9 and calculate the average ( $\bar{X}$ ). If an  $\bar{X}$  is less than 58.67 and  $\bar{X}$  is greater than 41.33, then accept the process. Otherwise reject the process as one which is generating a 2.5% or worse quality level. You will accept your process if it is working at a quality level of 2.5%, ninety-five percent of the time.

#### Example:

1. The output of your process is approximately Normally distributed
2. You have engineering tolerances of 50 +/- 10 and
3. You have a capability standard deviation of 1 - about 1/20th of the tolerance. Acceptance charts are a viable alternative for you!
4. You are primarily interested in supplying material which meets specs (not necessarily "in control")
5. You will be using samples of size nine to calculate  $\bar{X}$ .

Step 1. You want an AQL value of 2.5% - so choose  $k_1=2$

Step 2. The upper acceptable process mean is then:  $UAPL = 60 - 2 \cdot 1 = 58$

Step 3. You want a probability of acceptance of 0.975 - so choose  $k_2 = 2$  and the upper acceptable sample  $\bar{X}$  for sample size 9 is then:  $UAL = 58 + 2 \cdot 1 / \sqrt{9} = 58.67$

Now reverse this procedure to find Lower Acceptable  $\bar{X}$

Take LSL and add  $2 \cdot \text{std.dev. of } x$ 's to get Lower Acceptable Process mean:  $LAPM = 40 + 2 \cdot 1 = 42$

Subtract  $2 \cdot \text{std.dev. of } \bar{X}$ 's from this value to get the lower sample average:  $LAL = 42 - 2 / \sqrt{9} = 41.33$

#### Let's ask the customer...

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Please send your request and email address to: [matooley@stochos.com](mailto:matooley@stochos.com)

## 4 Simple Steps to Improve Customer Service & Reduce Costly Errors

- 1) **Track** - Properly track issues. The best way to accomplish this is via closed-loop tracking software. Closed-loop means that all reported issues require action from appropriate personnel, ensuring that no issues "fall through the cracks".
- 2) **Correct** - Define the cause of the issue and how to correct it. Identify who is responsible for the correction and when they are to complete it. Require personnel to validate the action when completed. On-line data allows supervisors to monitor activity completion, without the shuffling of paperwork.
- 3) **Prevent** - Reduce reoccurring issues and costly downtime by setting future dates to check corrective action effectiveness. Set up preventative maintenance tasks. On-screen alarms warn you when a task is overdue and needs to be completed.
- 4) **Report** - Report your data by valuable criteria (i.e. issue type, customer, machine, cause, cost) and analyze your savings.

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